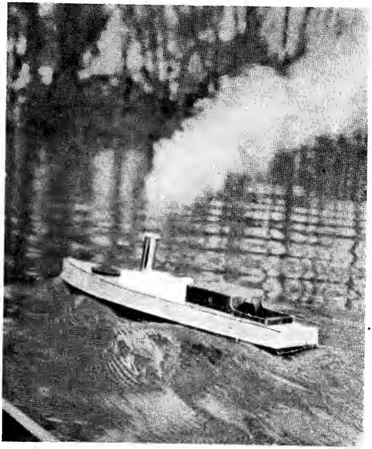
Hydraulic Extrusion Pipe Press

THE MODEL ENGINEER

Vol. 81 No. 2015 • THURS., DEC. 21, 1939 • SIXPENCE

In this issue



FULL SPEED AHEAD!

An impression of a model picket boat, made by Mr. J. Burgess of the Swindon Power Boat and Engineering Club, steaming on Rodbourne Cheney Lake.

THE MODEL ENGINEER

Vol. 81 No. 2015 60 Kingsway, London, W.C.2 December 21st, 1939

Christmas Greetings to all our Readers from the Editor and Staff of the "M.E."!

Large-scale Locomotives

IN our issue of October 12th last, there appeared an article, under the above heading, in which the case for large, true-to-scale locomotives was strongly defended, the comments being due to many years of experience and observation of the working of such locomotives in a number of different sizes and of a wide variety of types. A few remarks that had appeared some time before, in a provincial newspaper, were the direct inspiration of our article, and were rather strongly condemned. Several readers have since written to express whole-hearted approval of the comments we published, and to point out that, at this late date, such opinions as were expressed in the newspaper referred to, could not but be regarded as entirely old-fashioned. In this issue, however, there will be found an article from Mr. E. W. Twining, who has taken up his pen to express some strong comments in defence of the free-lance designs of locomotive. Our readers, no doubt, will be interested to compare Mr. Twining's remarks with those we published on October 12th; and, while we have no desire to open a long controversy on this matter, we shall be glad to know what our readers think. After all, it is the *practical* results that count, in the long run, and our readers' experiences with either true-to-scale or free-lance locomotives should do much to settle the question raised, especially with regard to performances obtained on 5-inch gauge, upwards.

* * *

Uses of "Prototype" Models

MANY model engineers who take great pains to construct miniature replicas of some definite prototype, frequently do so for the primary purpose of exercising skill; when the models are finished, they are usually put into glass cases, to be admired by posterity, and to serve no other purpose than to illustrate a certain phase in the history of the prototype. The more accurate the model is, the more valuable will it become in the future. This latter fact has not always been strictly realised by model makers in the past, as is evidenced by the inaccurate models of ships and locomotives that occasionally mar the collections exhibited in museums, for example. But another class of "Prototype" model maker prefers to work as closely as possible to scale while taking steps to ensure that the resulting models shall work in the same way, and by the same agency, as in the prototype. In this case, a double purpose is served; owing to the accuracy of outline and general arrangement, the value of the models tends to increase with the passage of time, while their ability to reproduce the actual working of the prototype tends to enhance the value to a considerable extent. And, in some instances where the model represents a proprietory example of engineering, such as some particular make of tractor, there is always the possibility that the manufacturers may be sufficiently interested as to consider the loan, or even the purchase of the model, for advertising or publicity purposes. Occasionally, we have been approached by manufacturers who have sought our aid in discovering good working models of their products; usually, we have managed to satisfy their requirements.

* * *

Enthusiasm at Edinburgh

A COPY of No. 2 of the Journal of the Edinburgh Society of Model Engineers, which has lately reached me, is full of life and good news about the activities of the members. In a report of the annual general meeting it is recorded that there has been a general revival of active model making, particularly in the locomotive section. Confirming this I read, later in the journal, that there are now eight or nine locomotives in course of construction, ranging from $2\frac{1}{2}$ in. to 5 in. gauge. I would also quote the following sentences:—"Our old friend Andrew Todd has been turning us green with envy, with his one inch scale works loco. which is proceeding apace. He gallantly hauls the weighty chassis and additions over from Kirkcaldy for our benefit, and we may say too for our education, for it is a fine piece of work." The inter-club spirit which prevails is exemplified by the accord of most enjoyable visits paid to the Glasgow Society and the Perth Society. The Glasgow members entertained their visitors right royally, and put up 150 ft. of temporary track under cover, for the occasion. At Perth, an equally cordial reception was extended to the Edinburgh members, and a special show of work was staged for their edification. The Edinburgh Society had arranged to return this hospitality in September, but this pleasure has perforce had to be postponed till more peaceful times arrive.

Percival Marshall

Model Engineers and National Service

*Capstan and turret lathes

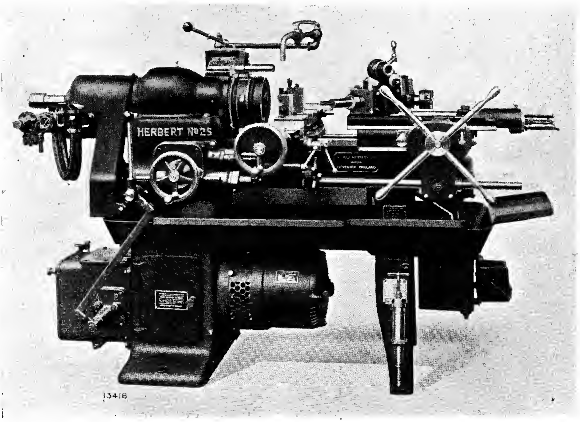
By Edgar T. Westbury

ALTHOUGH somewhat outside the subject of the article, a few notes on the variable gear unit may be of interest, as it is used on other machine tools than the one at present under discussion, and is likely to merit still wider application. It is known as the " H-gear," and its principle of operation is based on the use of two pairs of hardened and ground steel cones mounted on two parallel shafts, each pair being opposed one to the other so as to form virtually the cheeks of a vee pulley. A mechanical control is provided whereby the distance between the pair of cones can be increased, while that between the other is simultaneously decreased; or *vice versa*.

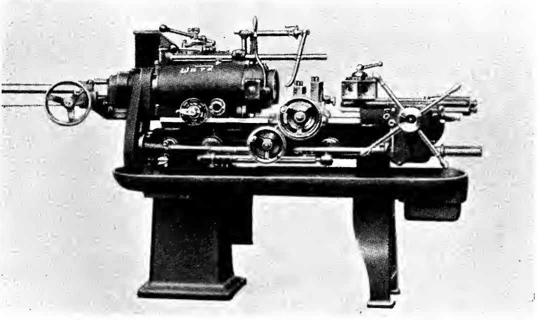
Variable gears of a somewhat similar type to this, employing a wide taper-edged belt as a means of transmission between the two shafts, have been used for many years for driving machine tools, but the H-gear differs from these in employing, in place of the belt, a hardened steel ring having its edges ground to fit the slope of the cones exactly. The precision with which the unit is constructed, and the fact that no tight belt or other means of pre-loading is employed, account very largely for the low friction and high efficiency of this device.

The lathe mandrel is of nitralloy steel, and incorporates a quick action collet chuck having a capacity up to ⅝" dia. It runs in phosphor-bronze bearings, provided with forced lubrication from a pump incorporated in the headstock. The oil system is equipped with easily removable filters and a pressure gauge, and a similar pump and filter system is provided for coolant supply.

**Continued from page* 651, *" M.E.," December* 14, 1939.



The Herbert No. 2S capstan lathe. (*By courtesy of Messrs. Alfred Herbert, Limited, Coventry.*)



The Ward No. 2A. capstan lathe. (*By courtesy of Messrs. H. W. Ward and Co. Ltd., Birmingham.*)

A five-station capstan is fitted, the pivot being inclined, to promote rigidity in the direction of thrust, and is operated through a rack and pinion from a four-armed windlass. The maximum working stroke is $4\frac{1}{2}''$. Both the capstan and the stops index automatically on the return stroke, and a time-saving device is incorporated to skip the idle strokes in cases where all the stations of the capstan are not in use.

The cross-slide, which may be of either the screw or rack-operated type, carries two tool-posts at front and rear respectively, and the maximum diameter which can be admitted over this slide is $3\frac{1}{2}''$, while the swing over the bed is $6\frac{3}{4}''$ dia.

Herbert Capstan and Turret Lathes

Among the larger and more fully-equipped capstan and turret lathes, those manufactured by Messrs. Alfred Herbert, Ltd., Coventry, and Messrs. H. W. Ward & Co., Ltd., Birmingham, are noteworthy. Both these firms produce a very wide and comprehensive range of machines to cope with every class of manufacturing production, and it is almost a certainty that one or other of these machines will be encountered by the model engineer who goes into armaments work. Incidentally, it may be noted that in spite of the very prevalent notion that only foreigners can make good machine tools, these lathes have been found capable of holding their own against any in the world, on the most exacting work, and under the keenest competitive conditions.

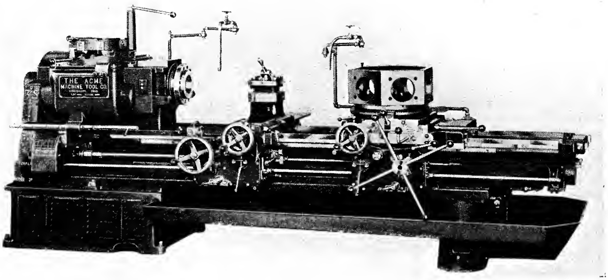
The Herbert capstan and turret lathes are made in 50 types and sizes, to deal with chuck work up to $33\frac{1}{2}''$ dia. and bar work up to $8\frac{1}{2}''$ dia. This range includes machines with both geared and cone-pulley headstocks, some equipped exclusively for bar work and others for chucking large castings or similar components.

For the manufacture of relatively light components, such as used in the automobile, aircraft and associated industries, the No. 2S capstan lathe, illustrated here, is extensively employed. It has a capacity of $1\frac{1}{4}''$ dia. through the mandrel, or $1\frac{1}{2}''$ dia. for short lengths of bar, and will accommodate a 6″ chuck for holding castings, forgings, etc. Equipment for compressed air operated chucks can be fitted.

The driving motor is attached to the right-hand (inner) side of the main pedestal, and is directly coupled to a gearbox on the left-hand side, which drives the headstock spindle by means of a flat belt and two-speed cone pulleys. The combination of gearing and cone pulley provides for a range of spindle speeds from 38 to 3,090 r.p.m., forward and reverse. Multiple-disc friction clutches are employed for starting and stopping.

The mandrel is hardened, and runs in ball and roller bearings, with provision for taking end-thrust in both directions. A two-step cone pulley is fitted to the tail end of the mandrel for driving the feed shaft, and the nose of the mandrel is flanged for the direct attachment of chucks. It will be obvious that the usual screwed mandrel nose has distinct disadvantages in lathes which may be subject to heavy torque loads in the reverse direction.

A capstan head having six tool positions is fitted, and indexing of both the capstan and its limit stops is automatic, but can be put out of action when not required. Self-acting feed is provided to the capstan slide by a feed shaft which runs the full length of the lathe, at the front of the bed, giving a choice of two rates of feed.



A heavy turret lathe by the Acme Machine Tool Co., U.S.A. (*By courtesy of Messrs. Buck and Hickman Limited.*)

The cut-off slide is equipped with patent "Duo-rate" cross feed, by means of which either fast or slow traverse may be obtained by a single handwheel. Adjustable stops to both saddle and cross-slide are provided, the former being capable of indexing to six positions. This particular type of lathe is not equipped for screwcutting, as are some of the larger ones of the Herbert range. Two demountable tool-posts of the open-side type are fitted, and a square turret tool-post can be supplied as an extra.

Ward Capstan and Turret Lathes

In this case also, it is impossible to deal in detail with the wide range of types and sizes of lathes manufactured by the firm in question, so one of the most popular types is taken as an example of the general features of these machines. The No. 2A capstan lathe, shown here, is an all-geared machine for single-pulley lineshaft, or individual motor, drive. It has a spindle running in ball or roller bearings, with a through chuck capacity of 1¼", and 5½" height of centre over the bed. A range of six spindle speeds in either direction is provided, from 48 to 1,020 r.p.m., when the main headstock pulley is driven at 450 r.p.m.; but speeds up to twice this amount are practicable and are often used when dealing with light work on brass and soft alloys.

Speed changing is effected through oil-immersed friction clutches in the headstock gearbox, and an internally expanding brake is fitted so as to bring the spindle almost instantaneously to a standstill when the clutches are disengaged.

The mandrel can be equipped with bar or jaw chucks, either of which may be arranged for hand or pneumatic operation. In either case, the gear for opening or releasing the chuck is totally enclosed in the headstock.

The capstan has a maximum working stroke of 6" when automatic indexing is used (this may be extended to 8½" by using hand indexing) and has six tool positions. Automatic feed is provided to the capstan slide and can also be fitted to the sliding saddle. In some of the larger lathes in the Ward range, provision is made for sliding and surfacing self-acting motion of the saddle, and screwcutting gear is also provided.

The Acme No. 35 Universal Turret Lathe

This is an example of a much heavier class of machine, applicable to such work as ordnance, large Diesel engines, etc. It is produced by the Acme Machine Tool Co., of Cincinnati, Ohio, and imported to this country by Messrs. Buck & Hickman, Ltd. The size illustrated will swing a diameter of 26½" over the bed and 18½" over the cross-slide; bars up to 4½" diameter (or diagonal, in sections other than circular) are admitted through the mandrel. Nine spindle speeds, from 8 to 266 r.p.m., or 12 to 400 r.p.m., are provided by the headstock gears, and 12 feeds, both cross and longitudinal, are provided to the turret and sliding saddle. The hexagonal turret has a maximum longitudinal travel of 57" and a cross travel of 9", the corresponding motions of the saddle being 56" and 14" respectively. A four-way tool-post is mounted on the cross-slide, either directly, as shown in the photo, or on a graduated swivelling slide. Screwcutting equipment can also be fitted.

The headstock of this lathe is unusually massive, a necessary feature in view of the high duty for which it is designed, and the mandrel runs in triple roller bearings. Forced lubrication is provided to all running bearings by an enclosed pump system, and the sliding ways are also equipped with special lubricating devices and oil wipers.

(*To be continued*)

*Gauges and Gauging

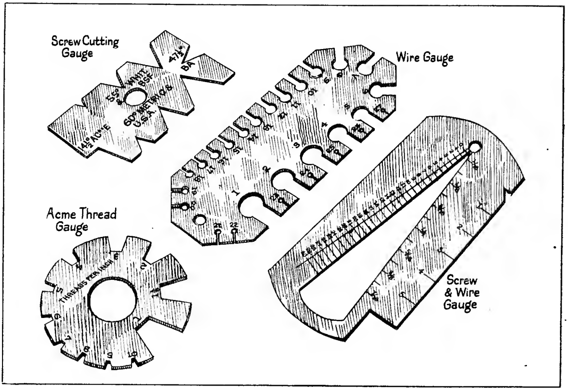
A series of great value to engineers of all classes, particularly those who are engaged upon national service

By R. Barnard Way

AMONGST gauges of the simpler form, we have still to deal with the profile variety. Strictly speaking, there is but little difference, in principle at all events, between the Template and the Profile Gauge. The former is a guide to the shaping of the work in hand, and so is the latter, but, in addition, the profile gauge can be adapted as a limit gauge to select the finished pieces. As we shall see shortly, the profile gauge can be used for limit gauging of parts that might otherwise be dealt with in other ways.

We cannot neglect some mention of the long series of workshop gauges for use in grinding lathe tools for screwcutting and other operations; the sheet thickness gauges, for deciding the exact standard gauge number to which it is rolled; the wire and drill gauges; the screw pitch gauges, and the flanks of their threads are by no means the same. No doubt most mechanics know that, but not all could say how many different angles there are to be found in general practice. What it means is that screw-threads that have to be cut on a lathe must be cut with a correctly pointed tool, and the point must be ground at the correct angle, or the thread will be worthless. Gauges can be had giving the principal angles, and it is not really necessary to have more than four. These are the Whitworth, 55°, which is also the angle for the British Standard Fine thread; the American Sellars, 60°; the British Association, $47\frac{1}{2}$°; and the Acme, 29°. Incidentally, the British Cycle Standard is also 60°, and the Metric too.

We illustrate a handy type of gauge for use as



Types of fixed workshop gauges.

a host of others to be found in every well-equipped shop doing general work.

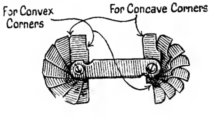
Screw-threads make a particular subject with which we have to deal fully at a later stage, here it is sufficient to mention that the angles made by a guide to the grinding of cutting tools for this work, and also one or two others of a similar sort, with a promise to return to the subject of gauging screw-threads shortly.

Sheet metal gauges are all of the same kind, they may be in rectangular form or circular, so you can have your choice! They hardly call for much

* *Continued from page 628, "M.E.," December 7, 1939.*

comment, except that they are precision tools, no less, and deserve better treatment than they usually get. We have already made some comments upon the degree of accuracy specified by at least one national sheet metal gauge. There are a considerable number of these standards of thickness and diameter, but the average shop will not need more than two or three for sheet or wire gauging.

There is a very useful type of screw and wire gauge consisting of a taper slot cut in a steel plate. All that is necessary is to slide the wire down the slot until it comes to a stop, where a clear indication is given of its gauge number. On the



Contour gauge for radius of curvature.

opposite side of the slot is shown its diameter—a most useful addition to any workshop kit.

The screw pitch gauge is also a handy tool to have wherever miscellaneous screws are in use, or liable to be met. It certainly was so in the old days when motor-cars with uncertain places of origin were being overhauled. Screw-threads, that looked a little like Whitworth's standard, were often damaged, but only needed running up with a chasing tool in the lathe. The pitch gauge infallibly recorded the fact that the threads were metric standard, and that no chaser was available for the job. Too bad, of course, but it saved a great deal of time all the same.

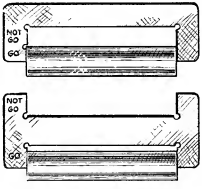
Drills that have seen service are apt to get their size numbers worn off the shanks—very often these are quite illegible in any case—but their size can very quickly be established with the aid of a drill gauge. This consists of a series of holes drilled with precision in a hardened steel plate, each hole numbered or dimensioned. Some of these gauge plates give an enormous amount of invaluable information about the job as well as the drill size, such as tapping sizes, and the like.

The feeler gauge is a well known addition to the kit of many motorists, and is an indispensable addition to any engineering shop where repairs have to be undertaken. These consist of a number of flexible steel blades, ground and finished to a high degree of accuracy in a selection of thicknesses. Made by a good firm, their accuracy is guaranteed to 0.0001″ at least. A typical set would range between $1\frac{1}{2}$ and 25 thousandths (0.0015″ to 0.025″), the blades being about 3″ to $4\frac{1}{2}$″ in length. Such a tool will give information of great value as to working clearances between parts; needless to say, quite indispensable information in such days as these when mechanical perfection is the only weapon a motorist has at hand to eke out his petrol rations. A long feeler blade will show even the clearance between piston and cylinder; this clearance is usually in the order of $1\frac{1}{2}$ thousandths for each inch of diameter for aluminium pistons, and 1 thousandth with cast-iron pistons. Thus, a 3″ aluminium piston would be given a clearance of 0.0045″, so that the feeler blade marked $4\frac{1}{2}$ (if there is one in the set) should go in between piston and cylinder wall, and should hold the piston up. If it does not, the clearance is excessive. When the feeler is withdrawn, the piston ought to slide down—lubrication is assumed to be satisfactory. The corresponding figure for a 3″ cast-iron piston is, of course, 0.003″, and the feeler marked 3 is the one to employ. A special set for piston and cylinder work is to be had, with limited range from $1\frac{1}{2}$ to 5 thousandths, rising by halves. The blades are 10″ long and $\frac{1}{4}$″ wide.

We make no apology for what is, apparently, something of a digression from our subject of limit gauging, but a little consideration will show that it has really a good deal to do with the main subject. Now we can return to the profile gauge.

Here we are upon ground that is close to the jig, for that invaluable aid to precision working is, in reality, little more than a template. The profile gauge we are directly concerned with is designed to test the finished part, and where it is a limit gauge also, to decide whether the part can be accepted or not.

There is not much real object in trying to make a profile gauge into a limit gauge in the majority of cases, the piece is either correctly shaped or not, and that may be the end of it. True, there



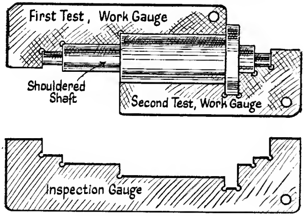
Gauging a plain shaft for length.

is probably a limiting shape above and below the normal shape, but it would not be easy to establish; and in consequence, the profile gauge is a "go" gauge and no more.

In spite of this, it is a most important type, and very essential in the scheme of gauging. Let us begin with a simple shaft, to be turned to a given length. We can certainly make a "go" and "not go" gauge of this—note that it is better to make the two limit gaps separate, in such circumstances, owing to the risk of the workman springing the gauge so that it will go where it

should not go. If the shaft is to have two or three different diameters at intervals along its length, it is as well to make these gauge to two separate profile gauges, as shown in the sketch. These give true indications of the length of the steps and their diameters. The inspecting gauge is in one piece, because we can more generally rely upon the inspector treating his gauge with more care, not attempting to spring it over the work.

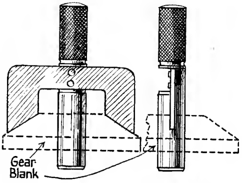
A valuable check when using a profile gauge is had by holding the piece, closely into the gauge, up to the light. Any chinks of light showing through will call attention to deviations from the true contour. It is actually the fact that light will show white through a gap of only 0.0001″, but less than that will show as a coloured light changing across the whole spectrum as it is moved, and as little as 0.00003″ can still be distinguished. Curiously, even narrower gaps show as brilliant black; though we need not trouble much about such deviations as that, it is of interest to record, and for the keen workman to try to achieve.



Gauging a shouldered shaft.

Gauging was a well-established principle during the last war, and every projectile made had to pass a long series of tests in the gauging departments before passing on to its dreadful work. One of these tests would certainly be for its profile in its finished state, complete with the copper driving band, and a common form of gauge for this purpose consisted of two plates, each making half the true contour, bolted to a rectangular frame. Rounded faces guided the shell through the plates, and if it dropped through all was well; there was certainly no time for watching out for optical effects as it went through. The writer was in charge of one of the heavy howitzers designed to hurl those projectiles out into space, and he regrets to have to say that very many of them were oversize, some incredibly so. At one time, when shells made by a certain concern were very common, we had to make ring-gauges of our own to gauge every shell before fusing it, the tiresome job of getting a jammed shell out of the breech having taught us a lesson or two. Almost every gun commander could tell a story of a dump of useless ammunition behind his gun that had cost a very useful sum of money that might have been saved by more attention to profile gauging.

Mention of armaments reminds us of the complicated shapes of many components of guns and smaller weapons, such as the machine gun.



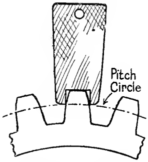
A contour gauge for bevel gear blanks.

Contour gauging enters considerably into the manufacture of these; it needs twelve separate gaugings before the cartridge chamber of a rifle is completely approved, though the limit imposed is no more than ± 0.003″ as a rule.

Complicated mechanisms are very frequently built up in dummy form, with a part missing. When this part is being made, the gauged pieces will be actually tried in this dummy set, and if they work all is well, if not they are rejected. The other parts are made to the maximum limit sizes, thus ensuring the maximum difficulty, and also the certainty that any properly gauged and approved piece will work satisfactorily with any other possible assembly. Gauges such as these are frequently called Functional Gauges.

Gear wheel gauging is another subject that demands a section of its own, but there are various

Gauging gear teeth.



simple types of gauges for operations during manufacture. Bevel gear blanks are tested for correct shape before putting on the machine by means of the simple profile gauge shown here. As the blank is already bored out for its shaft, this provides an obvious locating basis, so a plug is run into the hole. A plate with its outer ends bevelled off at the correct angle decides whether the blank is acceptable or otherwise.

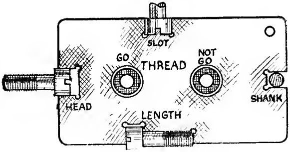
For gauging finished teeth, the handy plate gauge shown here is of some value. It has a

square slot cut in its end of a depth equal to the distance from the point of the tooth to the pitch circle. One width of the slot is equal to the proper width of the tooth at that circle.

To return to simpler subjects, the gauging of small screws is usually a matter for profile gauges. In some of the dimensions, "go" and "not go" gauges are used, and this can be easily understood as to the shanks and the screwed portions. Where the head is countersunk, it is also necessary to be precise. Again, if the head is of the cheese variety, and this has to be sunk flush or partly sunk, this must also conform to exact limits. We sketch here a useful type of gauge for testing the workmanship of small cheese-headed screws. In the centre of the plate are seen two bushes for gauging the screwed portion, one "not go" and one "go." The disadvantage of a gauge like this is that if one of the gauging slots gets worn at all the whole lot has to be scrapped.

A simple gauge for testing the head and shank of a countersunk screw is also shown. This speaks for itself, the screw is slid in sideways.

Wearing of gauges reminds us of an ingenious system we came across some years ago, to assist in controlling this trouble. Nothing lasts for ever, certainly not workshop gauges, some of which may be only good for one day, though they do not come within the category we have now before us. In this case, the gauges, after hardening and finishing, were electro-plated. Now, electro-plating is a very exact science, and it is known precisely just what thickness of copper (or other metal) will be deposited by a certain current flowing for any given time. If a film of copper only 0.00005″ thick be deposited over the working

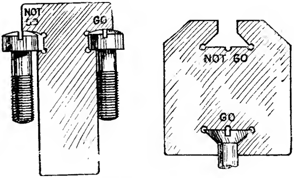


Gauging screws.

surface of the gauge, then its dimension has been increased by 0.0001″, and this can be allowed for.

In fact, this 0.0001″ can be regarded as the possible limit of wear of the gauge, and absolute evidence of wear to this extent will be forthcoming when bright steel shows up through the copper. To give the gauge a fresh start in life again all that is necessary is to give it another run in the plating bath.

Cycle parts, such as the hubs and the crank spindle are turned to special shapes that call for exact contour gauging, as well as limit gauging for the length, diameter, and general dimensions of



Contour gauges for screw heads.

the internal bearings and so on. Though these will be progressively gauged as the different operations are carried out, it is certain that the final viewing of the finished product will be a sequence of limit gauges secured to a board, so that every dimension can be checked in proper order. In this way, it will be possible to make the final decision in a few seconds, and also to decide whether any fault can be rectified. As to this, the whole scheme of limit gauging is built up on the idea that it is to cut out spoilt work, and that a component with many operations to go through will not survive to the end with any fault that calls for its rejection. These things do happen, inevitably, however much trouble be taken to avoid them.

(To be continued)

Filling Defects in Gunmetal and Brass Castings

DEFECTS such as blow-holes, contraction cavities, porosity and holes drilled out of position can be filled by either of the various methods briefly described hereunder.

One good method is to weld the defective places with the oxy-acetylene flame, using a filling-in material which, on account of its strength and colour, should be of the same composition approximately as the casting to be treated. A mixture of sodium borate and boracic acid should be used as flux. A neutral flame should be employed, and the inner cone of the flame should be kept from touching the metal. After welding, allow the casting to cool slowly. The welded area can be made practically invisible by grinding or filing off surplus metal and polishing.

A very good method where welding equipment is not available for filling small blow-holes and holes that have been drilled incorrectly in brass or gunmetal castings, is to drill out the holes carefully and tap them to receive threaded plugs made from brass and gunmetal rods or wire. The plugs should have, at least, three effective threads and screwed tightly into place, then cut off flush with the surface of the casting. If necessary, the plugs can be suitably polished to make them invisible.—A.J.T.E.

Parting Tools and Their Habits

By A. W. E. Weatherall

THE writer makes no apologies for this article on parting tools, as, judging by the number of " casualties " among this class of lathe tool in his own shops, it must, improperly handled (and ground), surely be the most " pesky " tool for apprentices or even improvers to use.

Incidentally, most of the troubles occur among the lighter types of lathes, say from 9″ centres downwards. Above this size, the tools can generally be made of sufficiently deep section and proportionately wide to hold their own.

Fig. 1. Plan view of offset tool.

Wherever possible, as wide a blade as is economical should be used. For example, when parting down 3½″ to 4″ material, a tool width of ¼″ to 5/16″ would not be out of place, but would obviously be out of all proportion on 1″ diameter and smaller, throwing needless strain on the stock operated on, to say nothing of waste of good material. A tool ⅛″ wide should be ample on this size, and owing to its smaller cutting surface would probably cut quicker, or at any rate easier.

Always part off as close to the chuck as possible, using an offset tool—see Fig. 1—if necessary to accomplish this end. Headstock bearings should have the last bit of shake adjusted up.

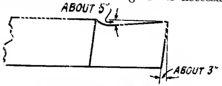


Fig. 2. A clean finishing tool.

It has been the writer's experience that it is very important to keep the front rake as stiff as possible, never exceeding about 3°, the tool set dead on the centre of the stock. Excessive front rake often causes chatter, owing to lack of support under the cutting edge.

As regards general shape, a good deal depends on the finish required on the sides of the article parted off. For a good, clean finish, such as, say, washers or collars, the writer prefers a tool with the usual side clearance (about 3° each side), but nearly parallel in plan from front to back, not more than, say, 0.005 smaller at back than front of blade, about 5° top rake and 3° front rake, as shown in Fig. 2.

For faster cutting where finish is not so essential, then a lip is, on steel, very beneficial, also more back clearance can be given. The lip can be ground in the top of the blade (see Fig. 3); or another good method (especially when using parting tool blades in a holder, which are parallel in their length) is to heat the end of the blade sufficiently to be able to tap up the extreme end with a hammer, as shown in Fig. 4. This latter is the practice on at least one type of cutting-off machine that the writer has seen, cutting off stock 8″ diam. and more; in this instance, the tools being fixed in a rotating head and the stock remaining stationary, the tools being fed in automatically.

To get back to lathe tools, however. The lip should always be an easy curve, so that the swarf comes off in coils. If the lip is ground, as in Fig. 5, the swarf will probably break and jam in the groove. (Operators at this point generally offer up a small thanksgiving service.) Dealing again with lip, the main thing is to get the swarf out of the parting groove. If the radius of the lip is too small, it has a tendency to make the swarf coil too tightly in the groove. This can cause a sudden jam when least expected, especially when the tool is a good way into the work, and either stalls the machine or breaks the tool.

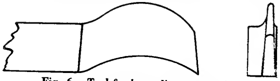


Fig. 6. Tool for large diameter work.

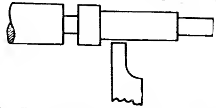


Fig. 7. Tool for straight turning and shouldering down.

Another very satisfactory shape of tool which the writer has used, especially on large diameter work, say from 4″ upwards, is one used upside down with the headstock motion reversed, either

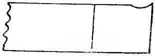


Fig. 3. Side view of lipped tool.

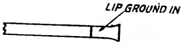


Fig. 4. Plan view showing swaging up of blade end.

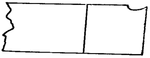


Fig. 5. Tool with ground lip.

through reverse-gear in the headstock or crossing the step-cone belt. It is forged out and ground in shape like a reap-hook, as shown in Fig. 6. Owing to the nice easy curved top or more rightly under-rake, plus the upside-down position which usually damps out any tendency to chatter, these tools are fast cutters and easy to handle.

For brass, any top rake at all is asking for trouble; in fact, a slight negative rake is often beneficial. The writer has found that a short stocky parting tool is very useful on brass or gunmetal for straight turning and shouldering down. The tool is best set with one corner slightly leading, as shown in Fig. 7; not much, only a question of a thou. or so A job as per Fig. 7—shouldered studs—would be produced without changing tools. Rough down stud to within about 0.005, and then take a shaving cut to size to produce a good finish.

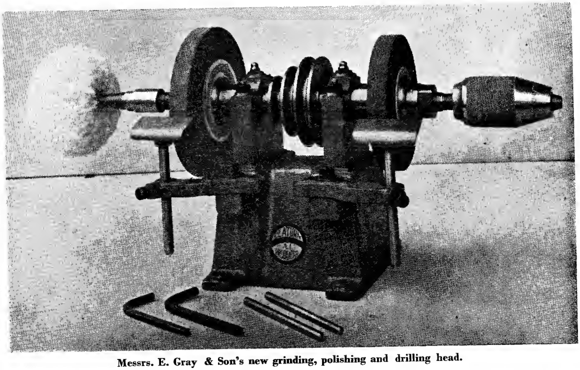
And now a few tips on using that nice lipped parting tool, Mr. Apprentice. Do not be over-cautious and hesitant when feeding the tool in, as this will often start chatter as quickly as anything. Run the tool up to the work; use plenty of cutting compound, and feed in steadily and firmly as though you meant business. When it starts cutting cleanly, keep it on the run, but do not forget to watch out for tightly packed coils in the groove and be ready to stop feeding immediately it seems like jamming.

A NEW LIGHT GRINDING HEAD

Messrs. E. Gray & Son, Ltd., 18-20, Clerkenwell Road, London, E.C.1, have submitted for our inspection an example of a light grinding, polishing and drilling head which they have recently introduced. It is an entirely British-made product, of superior workmanship and finish, and embodies many interesting features of design, including the use of ball-bearings enclosed in dust-excluding housings, with provision for grease gun lubrication, also universally-adjustable tool-rests, with tempered steel socket screws for locking. A locking-pin for the spindle is also provided, to facilitate the tightening or removal of the wheel nuts, and also a tommy-bar for dealing with the tapered extensions for carrying polishing mops.

The appliance is made in various forms, and sold at different prices, according to elaboration; the example illustrated is the most completely equipped, and includes a three-speed cone pulley for vee-belt, coarse and fine grinding wheels, a cotton mop on tapered extension spindle, and a British-made drill chuck taking drills up to $\frac{3}{8}''$ dia. A notable feature of the running of the machine is its perfect balance, due to the care and accuracy devoted to the turning and screwcutting of the mandrel and its running attachments, all of which screw on perfectly truly. The bearing housings are massive, and are separate from the box bed-plate, to which they are attached by means of long studs, after the manner of plummer blocks.

This useful tool will appeal to readers who are fastidious about their workshop equipment, for it will harmonise with tools and instruments of precision, and, what is more important, will justify itself in actual service.



Messrs. E. Gray & Son's new grinding, polishing and drilling head.

Hydraulic Extrusion Pipe Press

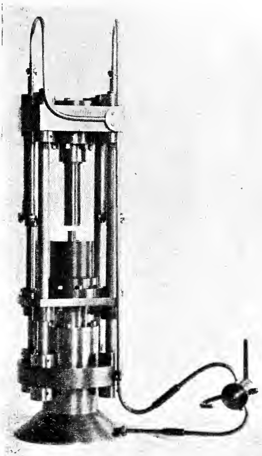
An experimental working model

By E. L. Michell

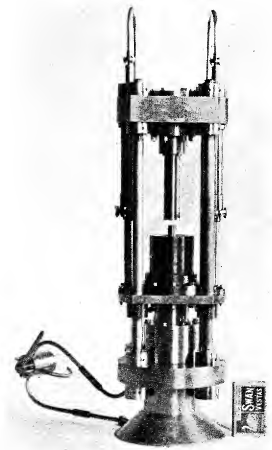
OVER the many years of THE MODEL ENGINEER'S existence I cannot recall off-hand having seen an actual working model of a pipe extrusion press, and I hope that the photographs and this brief description may be of interest. There is no intricate turning or delicate work about this model; it is not a glass-case job. It is meant for an experimental working model. It is built to stand ten times the pressure required, and although it differs in several points from pipe presses in actual use, does not look unduly out of proportion.

This is not the first extrusion press model I have built; the one prior to this was a similar model but smaller, made on a Drummond $3\frac{1}{2}''$ lathe, and for some time it stood on my office mantelpiece, till one day it caught the eye of approval of an official of a Research Association, who promptly " borrowed " it. Some weeks later I had a very nice letter from him, saying that " with alterations " it had been made to extrude lead wire, of which he sent me samples. But the press still remains " borrowed," and the work of many pleasant, and sometimes fatiguing, hours has ceased to exist as far as I am concerned. After this experience I determined to make a model press which would work " without alterations."

The model illustrated was built entirely on an Edgar $5\frac{5}{8}''$ treadle-driven lathe, which was purchased, on the spur of the moment, at one of the MODEL ENGINEER Exhibitions. By this I mean that when I entered the door of the Exhibition that particular year I had no intention of buying a lathe, the Drummond having given me good service for 14 years. But when I saw the Edgar,

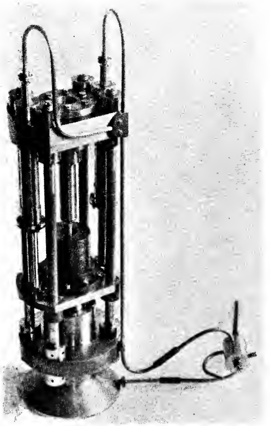


Rear view, showing piping.



Front of press, $24\frac{1}{2}$ in. high over pipes.

it struck me instantly as being the lathe I wanted for building the model I had in mind, so I walked on to the stand and had a word with the head of the firm. As far as I know, he had never seen me before, and with only my word for the condition of my old lathe, he promptly made me such a good offer of exchange that I accepted at once.



Overall view, showing arrangement at top of crosshead.

The deal lasted three minutes, and I am sure I was the more surprised of the two of us. I had not even considered whether I could get it through the trap-door of my attic workshop. However, it went through, and has been a splendid tool. I stick to treadle-drive, as I incline to the view that motor-driven tools tend to lift work out of the amateur class, but I know that this opinion is one that I hold alone. Many lose interest if a job takes too long.

The main cylinder of the model stands 6¼″ high, and is 6⅛″ dia. about its base and over the flange, which is 1⅛″ thick. The cylinder is bored out 5½″ deep and 2″ internal dia., and it is recessed at the top to take a hat leather. The outside dia. of the wall is 3⅛″. I like things to be strong. The forging for this cylinder was made for me by a friend, and it was on my lathe for over three months before I was satisfied with it. This may seem a long time, but it had to be mounted in a 6″ 3-jaw chuck, and the overhang was such that it was necessary to use backgear all the time. This is where a motor-drive would have come in useful from the point of view of speed, I will admit. Then again, I can only get a few hours a week in my workshop. As soon as the turning was finished, the cylinder was removed and the flange drilled for the columns, and the top drilled for six set-screws for the cover.

The next job was the main water-ram, which was turned from the back-axle shaft (broken) of a Thornycroft lorry. It is 6½″ long, and finished a slide-fit into the cylinder. It is bored and turned 4½″ deep and ¾″ dia., to take an "independent ram," which is used for forcing the core out of the container after sufficient pipe of one size has been made. The cylinder cover is just a steel washer, 9/32″ thick, which holds the leather down.

The columns were next on the list, and are just plain steel bars, ⅝″ dia. × 18″ long, screwed Whitworth thread, and the nuts are 1.5/16″ dia., and vary in thickness according to their purpose, those below the cylinder flange being 13/16″ thick, and those below the crosshead being ⅝″ thick. The table, or "bonnet" as it is sometimes called, is just a flat piece of steel, ½″ thick, with four brass bushes screwed in, which act as guides up the columns and ensure centralisation. It is also bored in the centre to allow the independent ram to work through it. The bonnet rests on the main ram but is not bolted to it.

The crosshead was the next job, and this was forged by the same friend who forged the cylinder. It is 1½″ thick with a flange on top, 3¼″ dia. × 5/16″ thick. It is taper-bored centrally from 1⅛″ down to ¾″. Besides being bored and drilled to take the columns and the bolts for the die-holding ram, it is also bored to take two jack-ram cylinders.

These jack-ram cylinders are 8⅜″ overall, and are turned from solid steel (back axles again). They are bored 4¾″ deep × ¾″ dia., and each is recessed at the bottom to take a hat leather, which is held by a brass gland. The return rams are ⅝″ steel rod, and they fit in brass guides bolted on to the bonnet.

The container is 3⅛″ deep, bored right through 1″ dia., the base of the core which forms the inside dia. of the pipe is a slide-fit into the container, and the core itself sits on the bonnet. The core used for the first experiment was ⅜″ dia. and the die ½″ dia. The die fits into a recess at the base of the ram, which can be seen bolted under the crosshead. The pipes from the reversing-valve to the base of the press, and also to the top of the jack-ram cylinders, are of stainless steel, ⅛″ bore × ¼″ outside dia., and were bent cold. The reversing-valve is a barrel, taper-bored, with a plug-valve ground in. This works well, and no pressure escapes from this.

For the purposes of experiment, a hand-pump, single plunger, was made, but these have been described elsewhere.

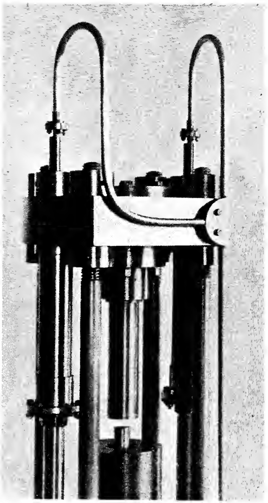
After many months, all seemed ready for a trial, and the tank was filled with oil. Neither tank nor pump are shown, as they are definitely not "show specimens." I use oil to prevent rust, the curse of all model engineers. On applying pressure to the base, oil first leaked from every joint there was, and a tray was hurriedly made out of sheet lead and the whole contraption placed therein. Every joint was tightened up, and the pump was tried again, this time it succeeded in forcing the ram out of the cylinder to the limit of its stroke, and on reversing the valve, the two jack-rams returned it again. So far so good, but there did not seem to be enough pressure to warrant trying the press with metal in the container.

Inspecting the Valves

The pump valves were taken to bits, the valves are only 3/16" steel balls, and they were clean and the seatings seemed all right, so they were put back. The trouble was eventually traced to the very small hat leather on the pump plunger. This plunger is only 5/16" dia., and some specially small leathers were made for me, and while these leathers would have been all right for water, oil is a slower running fluid, and I discovered that air leaked from the back of the leather, so that the plunger did not suck in its full quantity each stroke. The leather was taken off and packed at the base with a minute piece of graphited yarn packing. This made a tremendous difference, and I nearly broke my finger by trying it between the ram and container while pumping, so I decided to try it out with metal at once.

The container was taken off the model and this and the core were placed on the kitchen stove to get really hot, while some lead was melted in a plumber's ladle on the gas stove. As soon as the container was mad-hot, the lead was poured in round the core and allowed just to set. It was then wrapped in a rag, which promptly started smoking, rushed upstairs to my attic workshop, and placed on the bonnet (there was not time to bolt it on or the heat would have been lost). The pump went into rapid action, the main ram and container were forced up and up, the small ram disappeared into the container, sweat appeared on my brow, and finally lead pipe appeared out of the top of the press.

Success had arrived, it was a working model, "without alterations." The valve was reversed, and the pump applied again, the jack-rams were found to be easily powerful enough to return the container and main ram to their original position, and the first piece of pipe was cut off for inspection. It was beautifully smooth inside, but with only having a single-action plunger pump the outside of the pipe showed ridges caused by the momentary cessation of the flow of metal during the suction stroke. I am hoping to make a small set of three-throw pumps driven by electric motor, but as I took over three years to build the press, I fully expect it will take me two more to make the pumps. Perhaps the black-out will give me more time in my workshop.



Close-up of top of press.

Hydraulic machinery is, in the main, slow motion stuff, and, perhaps, that is why so few models of this class are produced. Nevertheless, it is interesting work and should receive more attention than it does. I only hope that these few notes may have interested someone. I have not put in any drawings, as I am no earthly use at making them, the only sketches I made were two for my friend who forged the cylinder and cross-head, and one for myself of the reversing-valve, and this last was only made to determine the position of the various inlet and outlet holes. If ever I finish the set of pumps sufficiently well to produce enough pressure to operate this model, I shall think I have really done something. Hydraulic pressure can be terrific.

The photographs were kindly taken for me by Mr. H. Reardon, of St. Helens, and every detail is shown on these.

A 5 in. Gauge Engine

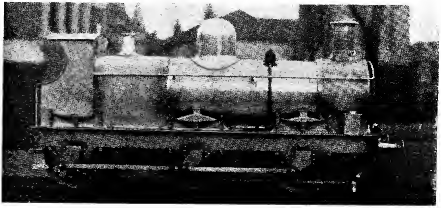
The first example of the model G.W.R. 0-6-0 locomotive, for which drawings and descriptive notes of the design were published in our last volume. The steam trial is described in the following notes

THE photographs published with these notes show the first example of the old-time G.W.R. goods engine for 5-inch gauge, drawings and a specification for which were published in our last volume. Due to the ready co-operation of Mr. W. B. Hart, who kindly lent his track at Streatham, the new engine was given her first steam trials on Sunday, November 19th last, in the presence of Messrs. F. H. Baldwin, J. C. Crebbin, W. B. Hart, W. H. Hart, J. N. Maskelyne, V. C. Storey, and G. S. Willoughby.

"Teething" troubles, naturally, were experienced, at the outset; the boiler displayed a disconcerting tendency to prime, and the mechanical lubricator firmly refused to function at first. After her pristine stiffness had worked off, and some gentle persuasion had been applied to the lubricator, no further trouble occurred, and the engine gave abundant proof that, in due course, she is likely to set up records in load-hauling and speed. During her first trial, however, a load-hauling test was not possible; but, with Mr. Baldwin driving, and hauling his weight plus a load of bricks, totalling about 20 stone, she reached a speed of about 15 m.p.h., and behaved as though she were hauling no load at all.

Mr. A. J. Maxwell, of Plymouth, for whom this decidedly fascinating engine has been built, requested the addition of top-feed clacks on the boiler, so that the minature "1188" (which is to be her number, in due course) shall conform with the "big sister," which spent some years working from Laira sheds, where Mr. Maxwell was stationed. The near-side clack delivers water from a "Linden" injector fitted on the footplate, while that on the off-side takes water from an axle-driven feed-pump. All the cab fittings are of proper G.W.R. pattern, made as nearly as possible to scale; the steam brake operating-valve is an almost exact replica, in appearance, of the G.W.R. vacuum brake ejector.

The "sandbox" on each side of the smokebox is actually an oil-well for supplying oil to the mechanical lubricator, which consists of a small oscillating cylinder driven by a pawl-and-ratchet gear operated by means of an eccentric mounted

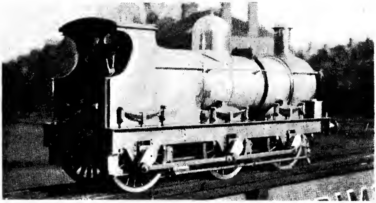


The engine ready for steaming. The tender is still to be completed.

The engine, with a "scratch" tender, on test.

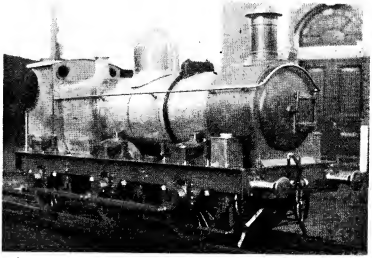
the buckle; the result is that the springs function quite satisfactorily.

The engine seems to be very light on coal consumption; on more than one occasion during her trials, she completed three circuits of Mr. Hart's 270-yard track, non-stop, on one firing, and travelling at anything from 10 to 12 m.p.h. The tractive force seems to leave nothing to be desired; what it actually amounts to has yet to be definitely ascertained, but a 30 lb. spring-balance, coupled between the tender and the driving-truck, was kept fully extended with the indicating-finger hard up against the stop, during a complete circuit of the track, up grade, down grade and level road notwithstanding. The calculated tractive force at 100 lb. boiler pressure, is 49 lb.; so that the actual practical result obtained with the only spring-balance available is, perhaps, not surprising!



Three-quarter rear view.

on the leading axle, and arranged to deliver a charge of oil into the cylinders once in approximately forty revolutions of the coupled wheels. A prominent feature of this engine is, that, although all external details are strictly to scale, most of them perform their proper functions; in fact, the only fittings that are included merely "for show" are the hand-wheel lubricator on top of the dome, the two dummy whistles on the cab roof, the hand-rails, and the footsteps. A portion of the cab roof is removable, to enable the controls to be easily accessible when the engine is working. At the time of writing, the tender is not completed; but, as on the engine, few, if any, of the details will be merely decorative. All the springs on engine and tender are of proper working laminated type, built up of the correct number of steel plates, and with double-link hangers attached to long bolts held in position by pads, nuts and lock-nuts. To eliminate as much friction as possible, small packing-pieces of zinc, ten "thous" thick, are inserted between each spring-plate, at



Perspective view, showing accuracy of general details.

Large-Scale Locomotives

By E. W. Twining

THE issue of this journal for October 12th contained an article under the above title, and with a sub-title which reads: " Comments on a statement made by a provincial paper."

It seems a pity that the contributor of the article either forgot to publish his name or, for some unexplained reason, did not wish his identity to be known; however, since the matter about which he writes very much concerns myself, I feel that I am called upon to defend the views expressed in the " Provincial Paper."

It concerns me because the statement which he criticises and which he quotes verbatim was made by me in an article in the *Northampton Independent,* published on August 25th last. Unfortunately, the anoymous writer, whom I will refer to as Mr. X, does not analyse the whole of the statement and argue it to its ultimate conclusion, and further he docs not tell " M.E." readers that the statement was only intended to apply to scale models which are called upon to do a certain class of exceptionally arduous duty, i.e., upon public passenger-carrying railways supposedly worked as paying concerns.

Most people who know me are aware of the fact that in a general way there can be no greater advocate of strict adherence to scale than myself, and it is largely due to the impossibility of economically working heavy trains with true-to-scale engines that I advocate complete departure from full-size prototype form and proportion and the designing of machines specially built for the jobs which they are required to do.

For the convenience of my readers I will repeat my assertion:—" Scale models are too complicated, have too many parts which are useless and cost money to make, whilst essential working parts are too light and wearing surfaces too small."

Mr. X's " fantastic travesty of the truth " and his " only possible conclusions " that the originator of the statement is possessed of " only the most meagre acquaintance with engineering principles " and " a complete lack of knowledge of the fundamentals of locomotive design," etc., can be passed over and I will endeavour to prove my case. At the outset, I will admit that it would have been better if I had said " unnecessarily complicated " instead of " too complicated," but the use of either expression was meant to be relative to the work to be done and relative to the cost; for that reason the first three points in the assertion were grouped together. In a great many cases the word " too " is not an exaggeration, though this depends largely upon the weight of rail and perfection of the track.

It will be admitted, I think, by most miniature railway engineers that a 4-6-0 or 4-6-2 wheel arrangement is certainly not necessary for the hauling of a train of passengers, provided the permanent way is capable of bearing the weight of the engine carried upon driving and coupled axles only and transmitting the tractive effort from them to the rail. It always is so capable and, therefore, idle wheels and axles are unnecessary, are better eliminated and all available weight utilised for obtaining adhesion. For this reason, the 0-4-2, 0-6-0 or 0-6-2 types are advocated.

Mr. X made no reference to the point in the statement regarding cost. This is a very important one in a commercial undertaking. There is not only first cost, but maintenance to be considered, and unnecessary wheels, axles, axle-boxes and portions of frames cost money to make and maintain. Some cost, too, is involved in other useless items, such as footplating, handrails and cab.

The next and last two points, the excessive lightness of working parts and smallness of bearing surfaces can also be dealt with together, since the relationship between cause and effect concerns them both.

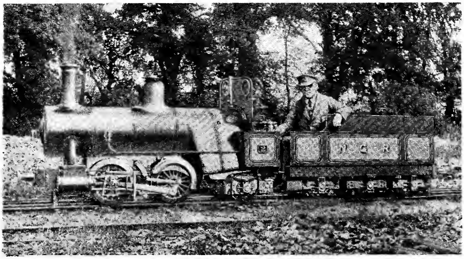
So I come to what is the crux of the whole matter, namely, scale reduction. The scale model, in all visible details, is reduced by a definite fraction of the size of the prototype, and all working rods, pins and bearings are made to that scale; thus a 15″ gauge locomotive is roughly one-quarter full size, actually it is about as 1 is to 3.76. A $10\frac{1}{4}''$ gauge engine is 1/5.3, and a 1″ to the foot model 1/12 full size. This is linear reduction. In order to find the theoretical weight of a model we have to divide the weight of the prototype by the scale cubed. Suppose we take the $10\frac{1}{4}''$ gauge as an example, and a G.W.R. " King " class as a prototype. The weight of the " King," loaded, is 89 tons, and we have, therefore,

$$\frac{89 \text{ tons} \times 20 \text{ cwt.}}{5.3^3} = 11 \text{ cwt. } 3 \text{ qrs. } 23 \text{ lb.}$$

Such a weight, say 12 cwt., for such a model is altogether out of the question, and the actual weight will be over twice as much, i.e., 25 cwt. to 28 cwt.

On the $10\frac{1}{4}''$ gauge railway in the grounds of the Castle and Zoo at Dudley, Staffs., the trains, when fully loaded with passengers, weigh approximately 117 cwt. This also is subject to the cube law, and we find that it is equivalent, in full size, to a train, including the engine and tender, weighing 865 tons.

A good many years ago the Eskdale Railway, of 15″ gauge, was worked by scale models, and one of the " Pacific " engines, the " Colossus," 4-6-2 type, should have weighed by the 3.76 cubed



Engine and tender, 0-4-2 type, designed by Mr. Twining for light industrial haulage, and for working miniature pleasure railways.

law 1 ton 13 cwt. 2 qrs. 10 lb. Actually, the weight was just over 2 tons. I have known this locomotive haul trains having a gross equivalent weight of nearly 700 tons. Is it fair then or reasonable to put a scale model with scale size axles and boxes, scale size crank-pins, and gudgeon-pins, big-end bushes, coupling-rod bushes and length of wheel seats on the axles, to carry their own excessive weight and haul such heavy scale equivalent trains? The consequence of doing so is that they are frequently needing repairs, new bushes and pins and the removal of all coupled axles because the wheels become loose on their seats, owing to inadequate thickness of wheel bosses.

I once drove " Colossus," with a train, non-stop, from Ravenglass to Boot. On arrival it was found that the trailing wheels of the engine were off the rails. I was told that " they often came off but it did not make any difference and they did no harm!" This is beside the point, but it merely illustrates my argument that certain axles are useless and can be done without.

There is another factor which operates in the direction of excessive wear or destruction of surfaces and moving parts, which is not generally realised, that is, that beside reduction by linear scale and cube scale the square of the scale is introduced in the relationship of model to full-size piston areas, and if a model locomotive was built with full scale cylinders it would be $\frac{1}{\text{scale}^2}$ more powerful than the prototype.

For the sake of steam economy, cylinder volumes are reduced, but the reduction in piston diameter is not sufficient to compensate matters, and the tractive effort, in spite of the fact that boiler pressures are about halved, is still much higher than that of the full size engine, with the result that working parts are still further overloaded.

This square law is amply demonstrated in the wonderful performances put up by models as small as half-an-inch to the foot, in which the large cylinders advocated by "L.B.S.C." are employed. In order to stress all parts in the mechanism of a model equally with a full size prototype, the boiler pressure should be reduced as the scale, but obviously the engine would not then be looked upon as a success because it would only pull scale equivalent loads. My point, then, is that if a miniature locomotive is needed for heavy duty day after day and week after week on a railway which is to show a percentage of profit on receipts, it is much more economical to depart from scale and put on the line machines which are specially designed for the work, for economy of first cost and subsequent maintenance. Such conditions are met by the engine which I have designed, and which is illustrated above.

The case of the private owner of a railway, who loves locomotives and scale models of them for their own sakes, is altogether different, and my arguments do not apply, because the engines are worked for but short periods and at comparatively short intervals. Even though they may be overloaded, years may elapse before the effects are noticeable, and then, perhaps, nothing more than big-end bushes will need renewing.

To me it has always seemed absurd, on a public railway, to haul the trains with engines whose chimneys are far below the level of the passengers' heads and whose driver is perched up so high on the tender that all sense of proportion in the engine is upset. Why build the engines cramped down to a loading gauge which does not exist? It is far better from the æsthetic, as well as the engineering, standpoint, and for other technical reasons too, to take the tops of the heads of the passengers, or the roofs of the covered cars, where such are used, as the height of the loading gauge and build the engines to that.

The Toad, Swamp and Punk Hollow R.R.

By "L.B.S.C."

THE small railroad bearing the above picturesque title is situated at St. Lambert, Montreal, Canada, and was built by Mr. A. W. Leggett, whose workshop and present activities were described last week. Before starting construction, our worthy friend was lucky enough to obtain some heavy section timber at a favourable rate, and pressed it into service; hence the decidedly "Bill Massive" look of the superstructure and sleepers, or ties as they are known in Canada and the U.S.A. The posts are cedarwood, and about 10″ in diameter, so there is not much fear of the whole lot collapsing and landing the engine "Calamity" into one of another kind! The road follows the usual practice as regards construction, so there is no need to go into detail. The rails are tee-iron, well spiked down, and laid for two gauges, $2\frac{1}{2}$″ and $3\frac{1}{2}$″. Two sidings are provided, for steam-raising and other "shed duties," and these are curved to conform with the movable part of the main line that can be swung around to line up with them, turntable fashion, allowing locomotives to pass from siding to main line, and vice versa.

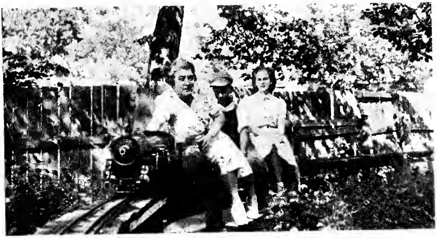


Photo by **Mrs. Leggett takes "Bill Jnr." and Willa for a ride.** *A. W. Leggett*

Though the railroad is usually operated by the locomotive and personnel shown in the picture—"Bill Senior," being behind the camera, naturally does not appear!—our friend occasionally holds a "meet," and on July 16th last, a very successful one was held, seven engines being in steam on the track, whilst on a "display table" there were nine more, some completed, and some in course of construction. It was an all-day gathering, visitors from out of town coming along in the morning, and the local lads rolled up later, everybody having the time of their lives. Mr. Leggett was highly amused, on reading an account in the local paper next day, to find they had given him the credit for building most of the visitors' locomotives. Oh, those reporters!

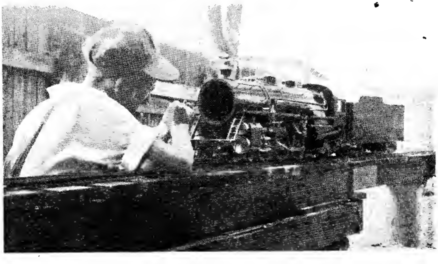


Photo by **"Shed Duties."** *A. W. Leggett*

Another Item of Interest

On the afternoon of Friday, November 24th, I took old "Ayesha" out on my road, and made a trip of $2\frac{1}{4}$ miles, feeding the boiler with water throughout the run by an injector similar to the one described for "Miss Ten-to-Eight," except that it was a little smaller, the delivery cone being drilled with a No. 80 drill. I have now found the right size of steam and combining cones to suit this weeny-weeny delivery cone, and the tiny jigger works fine. "Ayesha's" blowing-off pressure is, at the

moment, about 85 lb., and with the cones I have in the injector at present, it has a range from about 35 lb. (at which it will pick up) to blowing-off What the high limit is, I have not yet tested, probably about 110 lb. or maybe a little more. With steam full on, and the water-valve open half a turn, nothing comes out of the overflow whilst standing, and only an occasional drop whilst running, due to water going over with the steam. If the water-valve is shut, steam blows from the overflow, and on reopening the valve, the injector resumes duty at once. All the effect the injector has on steam generation is to stop the boiler blowing-off on the run.

An eccentric-driven pump still has one advantage over the injector, as the by-pass can be set to give a practically constant level in the boiler, and there is no need to watch the gauge glass; whereas, with injector feed, the glass needs watching, and the injector has to be started at low level, and shut off when the water reaches the top. Also, the jigger keeps on feeding when the engine stops, whereas the pump does not; and if you happen to forget to shut the former off, the water will soon come out of the whistle, as the enginemen say. However, many owners of small locomotives do not regulate the pump by-passes, merely turning them on and off, according to the level of water in the gauge glass; and, in such cases, the injector is no more trouble to operate, especially when it has single-handle control, as with my vertical sliding-cone pattern. Weighing up the pros and cons of pumps and injectors, I see no reason for discrimination in favour of either, and personally I am now fitting both to all engines. Anybody building one of my engines, in which I have specified twin axle pumps, can substitute a single pump and add an injector in lieu of the second. The old " Caterpillar " goods engine has four methods of boiler feeding, viz., twin eccentric-driven pumps, a duplex donkey pump, an injector, and a tender hand pump; so if

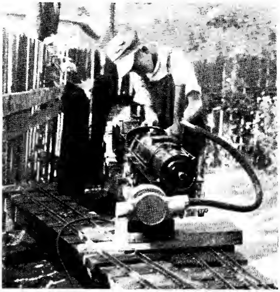
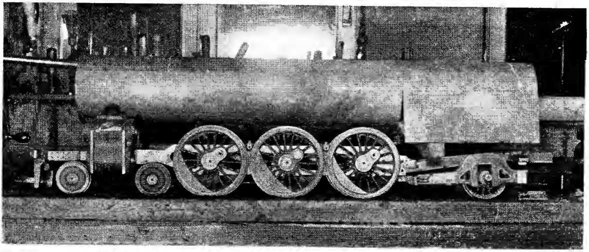


Photo by [*A. W. Leggett*

"Bill Jnr" gets up steam.

the driver ever " drops the lead plug " he deserves to miss the " Dewdrop Inn " on his way home in the black-out.

Followers of these notes have asked many times as to the possibility of fitting injectors to engines with water-tube boilers, and up to the present I have advised against it; but in view of recent experiments, and considering the small amount of steam needed by the gadget just mentioned, I now think it quite feasible, in $2\frac{1}{2}''$ gauge at any rate, to use one on a water-tube boiler without knocking the steam gauge silly. Of course, you can, if you so desire, fit an injector to *any* boiler; but it is not going to be of any use if, as soon as the steam-valve is opened, the pressure flops right down to zero, or pretty near it, and the locomotive quits work. I have heard plenty of tales, and seen a



Mr. Leggett's new " Pacific "—progress to date.

good many examples of that sort of thing happening to engines of quite respectable size, even 5″ gauge, in days of not so very long ago!

Comments

In reply to Mr. Keiller, who commented on the design of " Miss Ten-to-Eight's " smokebox, the reason why I did not specify the usual circular smokebox on a saddle was that I wished to keep to the outline shown on Mr. Chapman's drawing. Also, the inefficient engine that was the cause of the challenge " to design a better one," had a non-saddle smokebox with flat base, and it suffered from air leaks. Mine has the same outside appearance, but I do not think it will leak, as I made a similar one for a $2\frac{1}{2}$″ gauge locomotive which gave every satisfaction. It is no trouble to me to build up a non-saddle flat-base smokebox in steel plate, absolutely leakproof, by aid of my oxy-acetylene blowpipe; but it was of little use describing how to build it thus for " Miss Ten-to-Eight," as owners of oxy-acetylene outfits are in the minority, especially under present conditions. Hence the instructions and illustrations given; but should anybody fancy to use a circular smokebox on a saddle, there is, of course, not the slightest objection. As our friend correctly states, it entails less work.

Congratulations to Mr. Bragg-Smith on his " Princess Marina," which was built to my instructions in a contemporary journal. I do not think her performance on the road will disappoint him. A parallel case was that of Mr. Kelman, a Keston reader, who built a " Southern Maid " as a first attempt from the " Live Steam " notes, and never tried it under its own steam for lack of a suitable road. Making his personal acquaintance through a mutual friend, I invited him to try his engine on my own line, and he duly brought her along. We got up steam, and without the slightest hesitation, the little " Maid " started off and flew around the track hauling her builder, keeping it up until Mr. Kelman, in the excitement, inadvertently forgot to put the blower on whilst stopping to refill the tender tank and the lubricator; and the fire, which had burnt low, died out. The builder was astounded at the results of his own handiwork! He has now nearly completed a 5″ gauge " Eva May," 0-6-0 tank engine with Baker valve-gear, also to the designs of your humble servant.

Loco. Coal

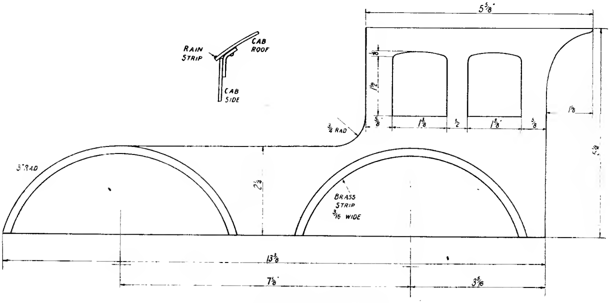
Re Mr. Harrison on coal-burning experiments, " donkey's years ago " as they say in the classics, I sent him some Ford patent compressed charcoal to try, and he sent me a sample of " Craigola " in return. As he says, it is good stuff; a $2\frac{1}{2}$″ gauge engine will haul a passenger half-a-mile or so on one firing of it. But long ago I gave up being " finicky " about coal. Full-size engines have to get along with whatever comes to them, and I figured that little ones ought to do the same. Our " Ideal " heating boiler lives and thrives on the Welsh coal supplied by our local merchant, which happens to be " Phurnod " No. 3 nuts, and my engines have to feed on the same stuff. We have a cinder sieve with about $\frac{3}{8}$″ mesh, and when the loco. coal gets low, I just heap up the sieve with the dust and small that usually accumulates in the coal shed. This is sifted into another home-made sieve consisting of a piece of perforated zinc with 5/32″ holes, which in turn is sifted on to a tray. The coal that remains in the home-made sieve, is what I use for the locomotives; and *do* they like it? It lights up rapidly, requires little draught, leaves not much ash and no clinkers. If I want to make a long non-stop run, especially with a wide firebox engine, I add an equal amount of anthracite peas, about the same size. But by arranging the blast, blower, etc., to suit, I find that steam can be got out of anything except granite chips and tarmac. The stuff that poor old " Ayesha " has had fed to her, during her long lifetime, would break any " finicky " engine's heart!

MISS TEN-TO-EIGHT

Superstructure

The top works on this locomotive are very simple, and the rawest tyro at platework should be able to make a first-class job of them. Sheet metal of 18 gauge should be used, and this may be hard-rolled brass, blue steel, or galvanised iron. My own pet method for an engine of this size, is to make up the whole complete side as one unit, running-board, splasher and cabside being cut out and brazed up with brass wire, using the oxy-acetylene blowpipe with a very small tip. This was how I made the superstructure for " Maisie." The assemblies were attached to the frame by pieces of angle, and screws. However, lacking the blowpipe, most builders will prefer the following method.

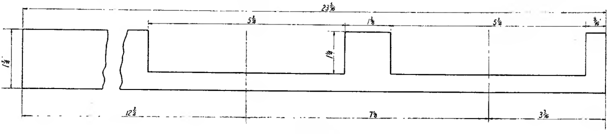
The running boards are plain flat strips, with pieces cut out to clear the driving-wheels and coupling-rods, as sketch, which gives dimensions. The side strips are attached to the top members of the buffer and drag beams, by a couple of $\frac{1}{8}$″ countersunk screws at each end, and are supported ahead of and between the coupled wheels by small pieces of angle, say $\frac{3}{8}$″ by 1/16″, attached also by screws to both running-board and frames. The edging of the running-board is a piece of $\frac{1}{4}$″ by 1/16″ angle brass, running the full length between the beams, and riveted to the underside of the running-board by 1/16″ brass or iron rivets, round heads underneath, shanks hammered down into No. 51 countersunk holes on top of the running-board, and filed off smooth. A make-up piece is fitted between the frames at the front end; this should not be screwed down, but merely made a tight push fit, easily removable to get at the lubricator. Another piece is fitted at the rear, to form the cab deck or footplate; this should be screwed to the top of the drag beam.



Combined splashers and cab side.

The splashers and side of the cab, are cut out as one piece; see sketch for dimensions. The shape and size of the cab front was given in the illustration of the footplate fittings; this can now be made, and fitted in position, suitable clearances being cut in it to allow room for the rear coupled wheels. The size of these is easily measured from the actual job. Before erecting the side sheets, solder a beading of 3/32″ half-round German silver wire around the window openings on the outside, also along the back edge of the cab. Runners can also be fixed on the inside of the cab sheets, above and below the windows, to take a piece of mica, as described for "Olympiade." It is funny how small things irritate certain folk, and you would hardly believe how it fidgets me to see a locomotive costing maybe a three-figure price, with just "aching voids" where windows ought to be! Curved strips of brass can also be soldered on to form splasher edgings. Small pieces of brass angle can then be riveted to the side sheets at the bottom, between the splasher outlines, and at the back corners of the cab; the whole doings is then erected, so that the front edges of the side sheets meet those of the front plate or weather-board, and the bottom of the splasher-plate is about ⅛″ from the edge of the running-board, and parallel to it. The bottom angles are then attached to the running-board by screws; you can tap the angles, and put screws in from underneath, through clearing holes in the running-board, or drill clearing holes through both, and use nutted screws or bolts, as desired.

The cab sides are attached to the weather-board by a piece of angle brass in each corner, secured by small brass countersunk screws. A strip of metal is cut to fill in the space between the top of the splashers, the frame, and the boiler; this extends from the bottom of the leading splashers to the cab, and may be soldered in position, a couple of pieces of angle being attached on the inside, to give extra stiffness. The cab roof is merely a piece of sheet metal, same gauge as sides, bent to the curve of the top of the weather-board, and edged with 3/32″ half-round German silver wire soldered on. It may be a fixture, or not, just as you like. If the latter, fit a little tongue in each corner, as sketch, to fit between cab sides. If the former, "ditto repeato," and put a screw through cabside and tongue to prevent any lifting.



Running board.

*Model Aeronautics

A series of articles dealing with the theory and practice of model aeroplane building

By Lawrence H. Sparey

BEFORE embarking upon a fresh topic, there yet remains some useful matter to be presented on the subject of undercarriages. As the reader may have gathered, I have a preference for pneumatic operation of these components, but this is not always possible—especially on the lighter types of petrol-driven models. Pneumatic contrivances must, of necessity, be somewhat weighty, and on models scaling under 2 lb. they are not, so far, a practical proposition. This leaves us with three alternatives; one, a solid, unsprung leg depending upon the resilience of the air-wheel (really a pneumatic type); two, damping by means of springs; or three, damping by means of rubber bands. It may seem that the last two are identical, but this is not so, as springs may be used in compression, whereas rubber bands must be used in tension.

Of solid, unsprung undercarriages there is little to say, beyond stressing the need for good strength of the fuselage at the points of attachment. If this essential is observed, they are quite suitable for machines up to 3 lb. in weight. Solid legs may be carved from whitewood or even hard balsa, in which latter case the leg should be drilled throughout its length, and a piece of $\frac{1}{8}''$ steel wire embedded through the centre. The leg may then be bound with Jap silk and doped. As previously mentioned, an advantage of the unsprung undercarriage is that it may be shaped to conform to almost any prototype without difficulty.

Some full-sized undercarriages are easily imitated if the model incorporates compression springs within telescopic tubes. Such an undercarriage is fitted to the American Douglas D.C.2—a trans-continental air liner greatly used on the Australian routes.

As will be evident from the illustration of the actual machine (Fig. 90), the undercarriage lends itself very well to model construction, but a lathe

* *Continued from page 645, "M.E.," December 7, 1939.*

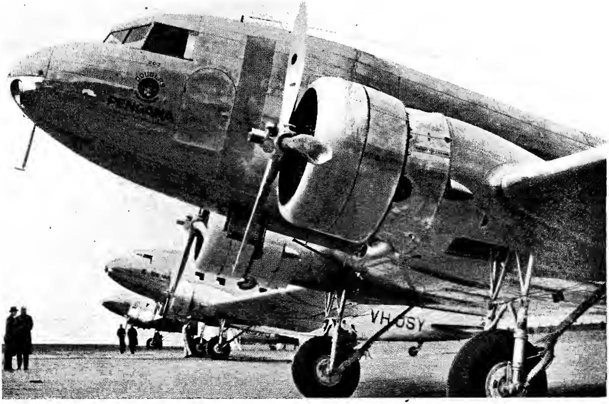


Fig. 90. A fleet of Douglas D.C.2 airliners, showing the retractable landing-gear. (*By courtesy of "Aeronautics."*)

would be almost essential for forming the telescopic forks. On the heavier types of model, these telescopic forks may contain small compression springs—or may even be stuffed with sponge rubber—while on the lightweight machines the legs may be quite passably imitated with stiff steel wire having pieces of brass tubing sweated over it to convey the idea of compression legs. Springing may be arranged as suggested in Fig. 91, which shows that the forked leg—bearing the airwheel—

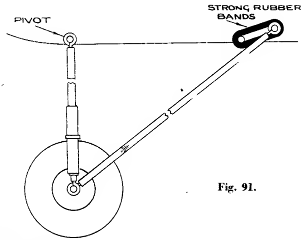


Fig. 91.

is pivoted at the top of the fuselage, while strong rubber bands, attached to the top of the rear leg, check the movement of the undercarriage. In looking at this drawing, it will, of course, be remembered that this is a side elevation. The front leg will, therefore, consist of two such members as the one shown; that is, one on either side of the wheel. These, being braced together by cross-struts, make the undercarriage very rigid.

On the real machine, this is a retracting undercarriage, and the rear leg serves only to brace the structure when in landing position. Nevertheless, it may be used in model work as part of the springing system, without any visible alteration in design.

Mention has just been made of retractable landing gear. So many full-sized aeroplanes have this fitment that it has become a real problem to the scale modeller. It is safe to say that, so far, no satisfactory retractable undercarriage has yet been evolved for model petrol-engined aeroplanes, although they have been used on rubber-driven machines. I have seen a good many of these, yet none is satisfactory for model "petrol" work by reason of the fact that they all *retract* but do not *extend* again for landing purposes.

The usual method is to hinge the legs to the fuselage, and retract them by the pull of rubber bands, the weight of the machine serving to keep the legs extended for taking-off purposes. As the machine rises into the air the legs snap upwards, but no mechanism is incorporated whereby they descend again as the model comes in to earth; thus leaving the machine to land on the belly of the fuselage. On light, rubber-driven 'planes, with folding propellers, this may not be a serious matter, but is unthinkable for power aeroplanes.

A fully retractable and extending undercarriage is certainly not beyond the realms of possibility, and offers a fine scope for the experimentally-minded enthusiast. I have toyed with the idea of an electrically operated solenoid to come into action as the engine cuts out, but, so far, weight and complications have kept the subject still in the realms of dreams. Nevertheless, I have constructed a fully retractable and extending undercarriage, for a rubber-driven craft, which was automatically operated by a pendulum device. Without giving details, it may be explained that it was arranged that the flying angle of the aeroplane, acting upon a pendulum, governed the position of the undercarriage. When climbing, the undercarriage was retracted, and when the gliding angle was assumed the legs were dropped.

Should experiments be undertaken with model retracting landing gear, it should be remembered that the legs should retract upwards or sideways, and not backwards or forwards. If these latter movements are followed, the centre of gravity of the aeroplane will be shifted as the legs are moved, and longitudinal stability will be upset.

The use of retractable undercarriages on model power 'planes will, however, always partake of novelty rather than usefulness. With rubber-driven duration or speed aeroplanes, there is a good case for their use; but as the power machine can never be flown with these two aims in view, the ability to retract the landing gear in flight serves no practical purpose. The duration of flight of a good model petrol 'plane depends upon the length of time for which the engine run is set,

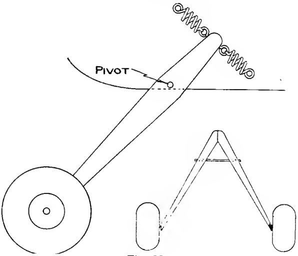


Fig. 92.

and not upon a decrease of parasitic resistance to motion through the air. Further, the model power aeroplane is not suitable for speed work, and cannot hope to compete with its rubber-driven counterpart in this field. A 36" span model speed aeroplane may have 1 lb. of rubber packed within

its fuselage This rubber motor is capable of developing 1 h.p. for several seconds—a power to weight ratio impossible to attain with the small petrol engine.

A useful system of springing for light undercarriages is shown in Fig. 92. Its construction is of the simplest, consisting as it does of two legs pivoted at the bottom of the fuselage, and extending upwards into the body of the aeroplane. At

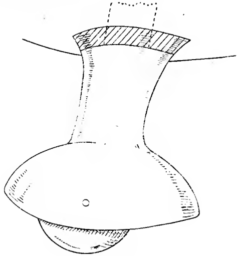


Fig. 93.

the upper ends the legs are braced together, and are steadied between two tension springs, or strong rubber bands. The operation is obvious.

For many years it has been the practice to partially enclose the wheels of some full-sized aeroplanes in streamlined cases, known as "wheel-spats." For model power-'plane work, spats have no aerodynamical value; in fact, they may be rather a nuisance, and may even *contribute* to the drag of the aeroplane, especially at our low flying speeds. Nevertheless, from the viewpoints of appearance and realism, they are distinctly valuable, especially on a model with any " scale " pretensions. They impart a sturdy and finished look to the undercarriage. An especially bold and modern appearance may be attained by forming the undercarriage leg and wheel-spat as one unit—somewhat after the manner shown in Fig. 93. This leg is almost an exact copy of those on the American " Lysander " aeroplanes, and is a good type to use with unsprung landing gear.

Should movement of the leg be incorporated, a neat junction between the leg and fuselage may be made by reducing the diameter of the tops of the legs, and slipping on a shaped piece of solid rubber at the junction with the fuselage. This will allow a restricted movement to the leg without displaying a gap, which would be fatal to the appearance. In the drawing, the rubber part is shown shaded, while the portion of the leg which enters the fuselage is indicated in dotted line.

When spats are not used, a well-finished appearance may be given to the undercarriage by shaping the lower end of the leg to blend into the shape of the wheel, as demonstrated in Fig. 94. This follows some actual aviation practice, as some full-sized machines, especially of the light class, have this feature.

Propellers

Starting with some notes on the theory of model aeronautics, these articles have dealt progressively with the design and construction of the component parts. None of these subjects has been extensively dealt with, and a return may be made to them as occasion may arise.

Before we may hope to design an efficient propeller some notion of the theory must be held. The general belief is that an aeroplane propeller screws its way through the air in an exactly similar manner to that of a woodscrew into wood. While there is a certain amount of truth in this, the matter is really much more complicated, as a correctly designed propeller works upon the aerofoil system, in exactly the same manner as the wing of the aeroplane.

Those readers who have followed these notes from the beginning will remember that in the first article it was shown why it is that a wing with a cambered top surface and a flat under surface will exert a lift if suitably moved through the air. They will remember that much of the lift was derived from the difference between the air pressure on the top cambered surface and that on the flat under surface of the aerofoil.

An exact parallel exists in the case of a well designed propeller blade; in fact, a propeller may be considered to be two correctly cambered wings revolving around a central axis; the lift being in a

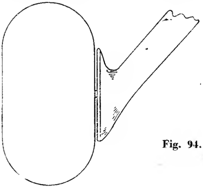


Fig. 94.

horizontal direction, instead of a vertical one as is the case with the main wing of an aeroplane. This being so, it is important that the blades or wings of a propeller be shaped to a correct aerofoil section, so that the " lift " may be the greatest possible.

The matter is somewhat complicated by the fact that, whereas the wing of an aeroplane moves in a straight line, the blades or wings of a propeller in flight describe a helix. Furthermore, each section of the blade moves on a *different helix;* the sections near the tip, for instance, moving on a

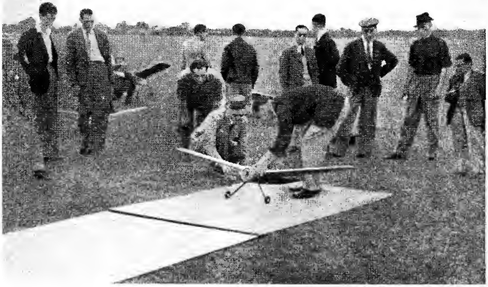


Fig. 95. Mr. Robertson's 6-ft. span mid-wing monoplane taking off. A well-streamlined machine with a neat undercarriage.

much greater helix than those nearer the boss. Still more complication is added by the fact that each part of the blade is moving at a *different speed*.

It has already been pointed out that the amount of lift derived from any aerofoil is largely dependent upon the speed with which it is moved through the air. Within limits, the greater the speed the greater the lift, so it is evident from this that considerable modification is required in the design of the propeller if a similar lift is to be derived from each part of the blades. Fortunately, the amount of lift may also be governed by the angle of attack at which the aerofoil is set; the greater the angle the greater the lift. So, although we cannot alter the relative speeds of the various sections of the propeller blades, we can alter the angle of attack of each section. Thus, it is possible to offset the increased lift of the fast moving tips by decreasing the angle of attack of the blades at these points; this is what is actually done, the angle of attack of the blades being gradually lessened towards the tips of the propeller. The angle at which blades are set is called the "pitch angle."

In speaking of propellers, it is usual to say that an airscrew is of a certain diameter and pitch. For instance, we may say that a propeller has a diameter of 12″ and a pitch of 8″. This means that a propeller of this diameter has the blades set at such an angle of attack that they will *theoretically* advance 8″ in one revolution. Actually, the term "pitch" has little value, except as a term of comparison between one propeller and another, as the actual advance of the propeller per revolution is governed by the speed at which it is revolving, and by the drag of the aeroplane to which it is attached.

Even were these modifying influences not present, the advance of a propeller through the air would be less than the theoretical pitch. This is because the air is a very fluid medium, with low inertia, which means that it is displaced very readily. Thus, there is always present a certain degree of slip, usually computed at about 25% of the theoretical pitch.

One sometimes hears the term "static thrust" used in connection with propellers. This term designates the thrust or pull given by a propeller which is revolved, yet at the same time secured so that it cannot advance at its natural forward speed. These tests are of little use to the model flyer, as it has been found in practice that the static thrust of an airscrew gives no indication of its flying qualities. High static thrust is useful for obtaining a quick take-off in rise-off-ground attempts, but it will be understood that an airscrew which is revolving and *progressing* through the air is performing under quite different conditions from one which is revolving and not moving forward. Static thrust may, therefore, generally be ignored by model flyers.

(To be continued)

Protecting Bright Steel Stock from Rust

The following tip may be of use to those amateurs who have to keep their bright steel stock in storage in damp places. Obtain a tin of petroleum jelly, which is quite cheap, mix with turpentine to form an emulsion; this mixture can be painted on the steel with an ordinary paint brush; the turpenine will dry out, leaving a thick coating of petroleum jelly to protect the steel from the damp.—R. N. J. Edmonds.